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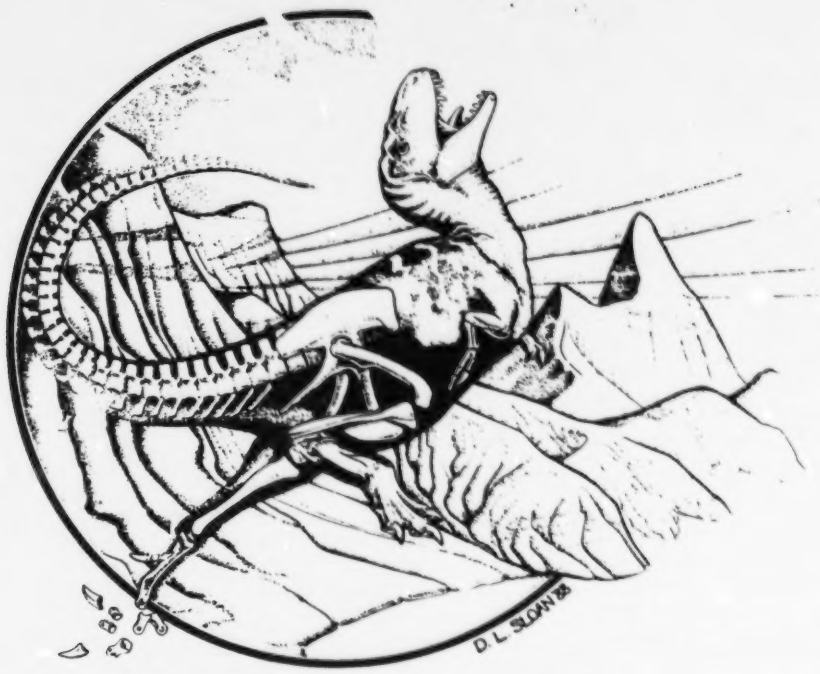

Society of Vertebrate Paleontology

48th Annual Meeting

FIELD TRIP "A" (October 11 - 12, 1988)

LATE CRETACEOUS AND PALEOCENE MAMMAL LOCALITIES OF SOUTHERN ALBERTA

by

R.C. Fox

OCCASIONAL PAPER OF THE TYRRELL MUSEUM OF PALAEONTOLOGY, #5

1988

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CULTURE AND MULTICULTURALISM

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Guide, Field Trip A: Late Cretaceous and Paleocene Mammal Localities of Southern Alberta

October 11-12, 1988

by

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My studies at the University of Alberta on Upper Cretaceous and Paleocene mammals from western Canada began in 1966; at present, these studies bracket a stratigraphic interval from early Campanian (Aquilan) to late Tiffanian (Ti_4), approximately 25 my, in Alberta and Saskatchewan (Fig. 1). The localities that we will visit on this trip cluster geographically around Calgary-Drumheller and Red Deer, Alberta, and range from late Maestrichtian (Lancian) to a middle Tiffanian (Ti_3) age; mammals from these localities are presently under study or are otherwise of interest (see KUA-1). Still other localities that continue to be important in my work, such as those in the Milk River and Oldman formations in Alberta (numerous publications), and near the Cretaceous-Tertiary boundary in Saskatchewan (Johnston, 1980; Johnston and Fox, 1984; Fox, 1987, 1988, in press, a, b) are too distant to be included in this trip.

Excavation of fossils in Alberta is by provincial government permit, under Alberta heritage resources legislation. This field party is covered by the permit given me for my research collecting;

because of that and because the localities of Paleocene age included here are each the focus of active collecting and research, I would be grateful if you would bring fossils you collect to my attention, so that I might retain any that are of importance to studies at UALVP. Any fossils to be exported require both provincial and federal permits governing removal of such materials from the province and country.

In the lists of species below, single asterisks indicate type locality for species, double asterisks, for genera. The descriptions of the localities and the lists that accompany them have for the most part been taken from Fox (in press, b), with modifications as appropriate to include work undertaken during this past summer.

Stratigraphic and Geographic Setting

Upper Cretaceous and Paleocene mammals from western Canada are at present known only from Alberta and Saskatchewan. In Alberta, the mammal-bearing sequence was deposited in the Alberta Basin, an elongate trough to the east of and roughly parallel to the present-day Rocky Mountains. The sequence begins with the upper member of the Milk River Formation, which crops out in a limited area in southern Alberta adjacent to the International Boundary; these beds are earliest Campanian in age, or Aquilan in land mammal chronology. Successively younger horizons in Oldman (middle Campanian; Judithian); Horsehoe Canyon (Fox and Naylor, 1986)/ St. Mary River formations (late Campanian/early Maestrichtian; Edmontonian); and Scollard Formation (late Maestrichtian; Lancian) bring the mammalian record in Alberta to very near the Cretaceous-Tertiary boundary (L. S. Russell [1975], Lillegraven, et al. [1979], Lillegraven and McKenna [1986], and Fox [1988] can be consulted for access to the original literature concerning mammals from this sequence). Although deposition across the K-T boundary without evidence of significant gaps (with the boundary being defined by palynofloral changes and the well-known iridium anomaly) has been

recognized in several regions in Alberta (see, for example, Jerzykiewicz and Sweet [1986], and Lerbekmo and St. Louis [1986], and references therein), latest Lancian and earliest Puercan mammals have yet to be discovered in the Province; for the latter, Dunbow Road (see below) appears the most promising possibility in Alberta among presently known localities. Torrejonian mammals have been found at only two significant localities in Alberta (Calgary 2E and Diss; see Fox, in press, b), while the Tiffanian record is comparatively rich, mostly from sites in the vicinity of Red Deer, but as far north as the Swan Hills and as far south as the Cochrane localities (see below) and the Cypress Hills, the latter in the southeastermost parts of the Province and extending into Saskatchewan.

The Saskatchewan beds were deposited in the Williston Basin, and are of Lancian through Puercan age in southwestern Saskatchewan (L. S. Russell, 1974; Johnston, 1980; Johnston and Fox, 1984; Fox, 1987; Fox, in press, a, b), and late Tiffanian (Ti_4) in the southeast (Krause, 1977, 1978). Of particular interest are the Lancian and Puercan strata in the vicinity of the Cypress Hills, where mammals very near to the K-T boundary, and on either side of it, have been found (Johnston, 1980; Johnston and Fox, 1984; Fox, 1987; Fox, in press, a, b); this continues to be an active part of my research program, in collaboration with Dr. John Storer at the Saskatchewan Museum of Natural History, Regina. The localities of relevance to this trip are listed as follows, with the first group being in the vicinity of Calgary and relevant to the first day, and the second group nearer Red Deer, and relevant to the second day.

DUNBOW ROAD

Porcupine Hills Formation (Carrigy, 1971), ?Puercan

(Fox, in preparation)

The Dunbow Road locality is at a small commercial quarry (the DeWinton Quarry of Demchuck, 1987) exposing brown sandstones, siltstones and shales, excavated for aggregate used in

the manufacture of bricks (J. F. Lerbekmo, personal communication, 1987); the quarry is immediately west of Provincial Highway 2, 10 km south of Calgary, in E1/2 S 36, T 21, R 1, W 5, at approximately 1098 m above sea level. The quarry was brought to my attention as a possible site for earliest Paleocene mammals by A. R. Sweet (see McIntyre, et al., 1984). In 1984, I located a seam containing broken molluscan shell at the quarry, which was sampled for underwater screening in the laboratory. The only mammalian fossil recovered was a single therian premolar; it possibly is from a condylarth, but no more precise identification is possible at present. Two more samples have been collected from the quarry, in July of 1987 and 1988, but these have not been processed at this writing. Dunbow Road is a "bad weather locality", with easy access, but will otherwise not be visited on this field trip.

Mammalia: unidentified genus and species.

CALGARY 2F (INCLUDING CALGARY 7F OF RUSSELL, 1929)

Porcupine Hills Formation (Carrigy, 1971), late Torrejonian (To_3)

(L. S. Russell, 1926, 1929, 1932, 1958; D. E. Russell, 1967;

Krause, 1978; Youzwyshyn, in preparation)

This locality, which L. S. Russell discovered in 1919, is recorded as being on the east bank of the Elbow River at Calgary, Lsd 3, S 4, T 24, R 1, W 5, and in the Paskapoo (now the Porcupine Hills) Formation. It is the source of the first Paleocene mammal from Canada (Catopsalis calgariensis) to be recognized as such (L. S. Russell, 1926). By 1958, the locality had evidently been destroyed by encroachment of commercial development accompanying the growth of Calgary, and/or by weathering, although L. S. Russell (1958) reported being still able to locate fossils in loose blocks of sandstone in the river bed (and see L. S. Russell and Churcher, 1972). No more recently collected fossils from this locality have been recorded (Krause, 1978); accordingly, the list below is from L. S.

Russell (1958), with appropriate taxonomic changes that have accrued since (G. P. Youzwyshyn, personal communication, February, 1987). This brief summary of Calgary 2E is included in this guide for purposes of completeness, but we will not be visiting the area of the site.

L. S. Russell (1958: 98), in reviewing earlier work (see Russell, 1932), considered the faunule "to be slightly older than the Cochrane faunules [q.v.] and more or less intermediate between the typical Tiffanian and typical Torrejonian." Krause (1978) thought a "very tentative" Torrejonian age for Calgary 2E was most appropriate (which is accepted here), while Sloan preferred a late Torrejonian (1970) or earliest Tiffanian (1987) age, the latter correlative with the Douglass Quarry local fauna, Montana (Krause and Gingerich, 1983). In his 1987 paper, however, Sloan (fig. 1) unaccountably shows "Calgary" (=Calgary 2E) as younger than "Cochrane" (= Cochrane 1 plus 2?), which is incorrect. The occurrence together of Baiotomeus, cf. B. douglassi, Eucosmodon molestus, Catopsalis calgariensis, and Tetraclaenodon, cf. T. puercensis indicates a late Torrejonian age.

Multituberculata: Baiotomeus, cf. B. douglassi; Neoplagiaulax, new species, cf. N. macrotomeus; Neoplagiaulacidae, unidentified genus and species; Anconodon cochranensis; Anconodon gidleyi; Eucosmodon molestus; Catopsalis calgariensis*.

Primates: Pronothodectes sp. (= "Microsyopinae, incertae sedis": Krause, 1978)

Carnivora: Protictis sp.

Condylarthra: Claenodon, cf. C. montanensis; Tetraclaenodon, cf. T. puercensis; cf. Tetraclaenodon sp.

COCHRANE 1

Porcupine Hills Formation (Carrigy, 1971), early Tiffanian (Ti_1)

(L. S. Russell, in Rutherford, 1927; L. S. Russell, 1958;

D. E. Russell, 1967; Gingerich, 1982; Youzwyshyn, in preparation)

R. L. Rutherford and L. S. Russell discovered the Cochrane 1 locality in 1926. It is cited (in L. S. Russell [1958], for example) as being at Cochrane, Alberta, on the north bank of the Bow River, in Lsd 7, S 4, T 26, R 4, W 5 (see Rutherford, 1927); the fossils came from rocks now recognized as part of the Porcupine Hills Formation, but earlier included within the Paskapoo Formation. L. S. Russell (1958) stated that the only identifiable mammalian remains known from this locality were found in 1926; until 1988, no collections more recent than those in L. S. Russell's (1958) summary, were made. In August, 1988, G. Stonley and G. P. Youzwyshyn (UALVP) rediscovered Cochrane 1 and made collections from it; at this writing, these specimens have yet to be prepared and studied. Hence, my list of mammals from Cochrane 1 follows L. S. Russell (1958), with up-dated taxonomic changes (from G. P. Youzwyshyn, personal communication, February, 1987); the occurrence of Ectocion collinus at Cochrane 1 is indicative of an early Tiffanian age (see Gingerich, 1982). Owing to time constraints, we probably will not stop at Cochrane 1, but its location will be pointed out.

Multituberculata: Anconodon cochranensis*.

Condylarthra: Ectocion collinus*.

Eutheria, order incertae sedis, Pantolestidae: Propalacosinopa septentrionalis*.

COCHRANE 2

Porcupine Hills Formation (Carrigy, 1971), early Tiffanian (Ti_1)

(L. S. Russell, in Rutherford, 1927; L. S. Russell, 1929, 1932

1958; D. E. Russell, 1967; Krause, 1978; Gingerich, 1982; Youzwyshyn, 1988; Fox and Youzwyshyn, in preparation)

This locality, in the Porcupine Hills Formation .5 km east of Cochrane, is one of the more important localities yielding Paleocene mammals in western Canada. The fossils come from beds at a southward-facing outcrop in SE1/4 S 1, T 26, R 4, W 5, at about 1059 m above sea level; the outcrop overlooks the Bow River and the main transcontinental line of the Canadian Pacific Railroad. (Access to this site is along the CPR tracks; please keep alert for trains.) R. L. Rutherford and L. S. Russell discovered the locality in 1926; it is here called "Cochrane 2", a name intended to replace the names "Cochrane 11" (as in Rutherford, 1927; L. S. Russell, 1928; D. E. Russell, 1967; and Krause, 1978, for example), and "Cochrane II" (as in L. S. Russell, 1929; and Gingerich, 1982, for example). Present ambiguities about the name of this locality are such as to confuse even knowledgeable workers, such as Savage and D. E. Russell (1983: 53), who have listed "Cochrane 2" and "Cochrane 11" as separate localities having different ages, which is incorrect.

Early papers concerning the Cochrane 2 mammals include Rutherford (1927) and L. S. Russell (1929, 1932, 1958). From this early work, L. S. Russell (1965, for example) believed the Cochrane mammals to be Clarkforkian (latest Paleocene) in age, while Sloan (1970: fig. 5) thought them to be middle Tiffanian.

Field parties from UALVP have made a number of collections at Cochrane 2, beginning in 1969. At the main cut, mammals have been found at only one horizon, about 17 m above the CPR tracks, in calcareous gray-greenish siltstones and shales containing gastropod and bivalve shells, coalified fragments of wood, and occasional, well-rounded pebbles. The mammalian fossils occur within an interval that varies between a few centimeters and one meter, along about 30 m of strike, beginning at the west end of the outcrop. (In 1988, G. Stonley and G. P. Youzwyshyn discovered a

second occurrence of mammals, in a slump block about 30 m west of Cochrane 2; the source of the block is not known at present. This occurrence has been dubbed Cochrane 2B; the fossils from it await identification.) L. S. Russell (1929: 167) stated that the mammal horizon at Cochrane 2 is "about 300 feet, stratigraphically, above that of locality 1"; this has not yet been checked independently, although it is now possible to do so, with rediscovery of Cochrane 1. The UALVP collecting at Cochrane 2 has been by quarrying and splitting the fossiliferous rock on-site in the attempt to recover jaws, followed by underwater screening of the residual quarried rock in the laboratory, for isolated teeth. D. W. Krause (1978), who made significant collections at Cochrane 2 for UALVP during 1972-1977, described the primates from the site and concluded that they indicated a "latest Torrejonian or latest Tiffanian-----age but, provisionally-----the former" (p. 1269). Krause's (1978) estimate that the mammals from the Porcupine Hills Formation at Cochrane were older than those from the Paskapoo Formation in the Red Deer River valley contradicted Carrigy's (1971) contention from lithostratigraphy that the Porcupine Hills Formation was in fact younger than the Paskapoo. Demchuck's (1987) review of the palynostratigraphy of these same beds shows that Krause (1978) was correct, as does the work on mammals from the two formations subsequent to Krause's.

G. P. Youzwyshyn is currently completing a review of the mammals from Cochrane 2 (based on approximately 1700 identifiable specimens) for his M. Sc. research at The University of Alberta (UA): he has determined that the Cochrane 2 local fauna is earliest Tiffanian in age (from the occurrence of Nannodectes intermedius, Plesiadapis praecursor, Elphidotarsius russelli and Ectocion collinus; and see Krause, 1978, Gingerich, 1982), approximately correlative with the Douglass Quarry local fauna, Montana (see Krause and Gingerich, 1983). (For completeness, it should be noted here that Sloan's (1987) assessment of the "Cochrane" locality [locality number unspecified] as older than Calgary 2F is erroneous.)

The Cochrane 2 local fauna includes over 80 mammalian species (Fox and Youzwyshyn, in progress) (as compared to the nine species cited in the most recent prior summaries), an unexpectedly large number for the early parts of the Tiffanian: the Tiffanian is an interval thought to show a dramatic decline in mammalian diversity from a Torrejonian high as a consequence of global cooling from a subtropical to warm-temperate regime (see, for example, Sloan, 1970; Gingerich, 1976, 1980; Gingerich, Rose and Krause, 1980; Rose, 1981a, b; Krause, 1984). If such an event took place, it occurred only after the time that the Cochrane 2 local fauna represents (assuming that a change to a more temperate climate would depress mammalian species diversity); as shown below, however, the high number of mammalian species from middle Tiffanian localities along the Blindman River, near Red Deer, Alberta, makes that alternative unlikely, as well. Continuing research by D. W. Krause (Krause and Maas, 1987; Krause, personal communication, May, 1988) at Douglass Quarry, Montana, also has failed to reveal a depression in mammalian species numbers in the early Tiffanian.

The list below is the consequence of my own review of the mammals from Cochrane 2; for Cochrane 2, "cf." means "compare with". The list does not include the results of extensive new collections quarried during June-August, 1988, for UALVP by G. Stonley and G. P. Youzwyshyn.

Multituberculata: Ptilodus, new species 1 (see Krause, D. W., unpublished Ph. D. dissertation); Ptilodus, new species 2 (see Krause, D. W., unpublished Ph. D. dissertation); Ptilodus, new species 3; Baiotomeus, new species; Ptilodontidae, unidentified genus and species; Mesodma pygmaea (see Sloan, 1987); Mimetodon silberlingi; Ectypodus, cf. E. szalayi; Ectypodus sp; Parectypodus sinclairi; Parectypodus, cf. P. sylviae; Parectypodus, new species; Neoplagiaulax, cf. N. hunteri; Neoplagiaulax nelsoni; Neoplagiaulacidae, unidentified genus and species; Anconodon cochranensis; Anconodon gidleyi; Anconodon sp.; Eucosmodontinae, unidentified genus and species; Acheronodon, new species; Pentacosmodon sp.

Marsupicarnivora: Peradectes sp.

Lipotyphla: Litocherus, cf. L. lacunatus; Litocherus sp.; Erinaceidae, unidentified genus and species; "Leptacodon" munusculum; Leptacodon, cf. L. tener; Leptacodon, cf. L. packi; cf. Nyctitherium, new genus and species; Limaconyssus sp.; Nyctitheriidae, unidentified genus and species.

Dermoptera: Elpidophorus, cf. E. elegans.

Primates: ?Palaechthon sp.; Plesiolestes, cf. P. sirokyi; Ignacius fremontensis; Ignacius, cf. I. frugivorus; ?Pronothodectes sp.; Nannodectes intermedius; Plesiadapis praecursor; Plesiadapis, cf. P. anceps; Elphidotarsius russelli*; Carpodaptes, cf. C. hazelae; Picrodus silberlingi;

Carnivora: Simpsonictis pegus; Simpsonictis, cf. S. tenuis; Viverravidae, new genus and species.

Creodonta: unidentified genus and species.

Condylarthra: ?Oxyprimus sp.; Chriacus pelvidens; Chriacus, cf. C. baldwini; Thryptacodon orthogonius; ?Oxyclaeninae, new genus and species; Colpoclaenus, cf. C. keeferi; Claenodon, cf. C. montanensis; ?Claenodon sp.; ?Mimotricentes sp.; Desmatoclaenus sp.; Ectocion collinus (Gingerich, 1982); Litomylus dissentaneus; Litomylus, new species; Apheliscinae, new genus and species; Mesonychidae, unidentified genus and species; ?Periptychidae, unidentified genus and species.

Pantodonta: unidentified genus and species.

?Rodentia, cf. Mimotonidae (Li and Ting, 1985): unidentified genus and species.

Eutheria, order incertae sedis, Palaeoryctidae: Palaeoryctes, cf. P. punctatus; Pararyctes pattersoni; Pararyctes, new species; Didelphodontinae, unidentified genus and species; Palaeoryctidae, unidentified genus and species 1; Palaeoryctidae, unidentified genus and species 2; Palaeoryctidae, unidentified genus and species 3; "palaeoryctoid", new genus and species. Leptictidae: Prodiacodon, cf. P. puercensis; Prodiacodon concordarcensis; Prodiacodon furor; Myrmecoboides montanensis. Pantolestidae: Propalaeosinopa septentrionalis; Paleotomus senior; Paleotomus, new species. Pentacodontidae: Bisonalveus browni; Pentacodontidae, new genus and species. Mixodectidae: Eudaemonema, cf. E. cuspidata. Apatemyidae: Jepsenella, cf. J. praepropera. Eutheria, unidentified genus and species (cf. Thylacaelurus).

AARON'S LOCALITY

Paskapoo Formation, early Tiffanian (Ti_1 or Ti_2)

(Fox, in preparation)

This locality was discovered by W. Roberts, from the Museum of Zoology, UA, and his son Aaron in June 1987; it is at a small roadcut, 42 km east of Innisfail, Alberta, in NW1/4 S 15, T 35, R 24, W 4, at about 876 m above sea level. The fossils occur with clay galls in a hard, brownish channel sandstone, and show evidence of postmortem abrasion. Samples taken from the site for underwater screening in the laboratory have been partly processed at this writing, with six mammalian taxa having been recognized; two of these, Ignacius fremontensis and cf. Bisonalveus browni suggest an early Tiffanian age. We will probably not visit Aaron's Locality; it is included here for completeness of coverage of localities in the region.

Multituberculata: Ptilodus, cf. Ptilodus, new species 1 of Krause (1982);

Primates: Ignacius fremontensis; Elphidotarsius, cf. E. wightoni.

?Creodonta: unidentified genus and species.

Eutheria, order incertae sedis, Pentacodontidae: Bisonalveus, cf. B. browni.

HAND HILLS LOCALITIES

Paskapoo Formation (Carrigy, 1971), Tiffanian

(Fox, in preparation)

The Hand Hills are an erosional remnant plateau located approximately 25 km northeast of Drumheller, Alberta. They are capped by gravels that range from Miocene to Pleistocene. In the summer of 1981, D. B. Schowalter collected several isolated mammalian teeth from bentonitic shales poorly exposed in a small roadcut on the north slope of the Hand Hills below the level of the gravels; in 1983, several more teeth and tooth fragments from this site were collected by Schowalter and Dr. B. G. Naylor, Tyrrell Museum of Palaeontology. These collections are housed in UALVP. In 1984, I visited the site but found no additional fossils.

This locality is now known as Hand Hills East; it is in SW1/4 S 14, T 30, R 17, W 4, at about 1044 m above sea level. The mammals from Hand Hills East are not diagnostic as to age, but owing to the nearness of the locality to localities immediately to the west that are rich in mammals and are at a similar altitude (see below), Hand Hills East is undoubtedly Tiffanian.

In 1984, I discovered a rich bed of vertebrate fossils, including mammals, in a large roadcut approximately 1.7 km west of Hand Hills East. At this site, in SE1/4 S 21, T 30, R 17, W 4, at approximately 1052 m above sea level, the road cuts through pale gray to buff shales and siltstones beneath the capping gravels. The mammals occur in a thin brown to dark gray shale layer in

association with broken molluscan shells, and consist of isolated teeth and tooth fragments, and jaw fragments with teeth; in this layer, fossils of Amia and Champsosaurus are especially abundant. The productive layer is near the top of the roadcut, and is scoured down into the paler shales beneath, producing a shallow, but temporally important, disconformity. Large samples were taken from this layer for underwater screening in 1984-86, and it has been named "Hand Hills West, upper level"; from the occurrence of Plesiadapis rex, the mammals from this layer appear to be middle Tiffanian in age.

In August 1986, I discovered a second layer at Hand Hills West containing molluscan shells and vertebrate bone, in a gray shale approximately 22 m below the first, along the same roadcut. A small sample taken for underwater screening showed the presence of mammals in this second layer, now called "Hand Hills West, lower level"; the primates indicate an early Tiffanian age. A large sample was collected from this layer in 1987 for underwater screening in the laboratory, but has not been processed at this writing.

The two layers at Hand Hills West are especially important in being in superposition, an uncommon relationship among the mammalian occurrences discovered so far in the Paleocene of western Canada. Demchuck's (1987) palynostratigraphic estimate of the age of the shales below the disconformity is consistent with the early Tiffanian age indicated by the mammals from the lower level.

Hand Hills East: Tiffanian

Multituberculata: unidentified genus and species.

Hand Hills West, lower level: early Tiffanian (Ti_1 or Ti_2)

Multituberculata: Neoplagiaulax, new species.

Primates: Elphidotarsius russelli; Picrodus silberlingi.

Eutheria, order incertae sedis, Palaeoryctidae: Pararyctes sp.

Hand Hills West, upper level: middle Tiffanian (Ti_3)

Multituberculata: Ptilodus, new species 2 of Krause (1982); Baiotomeus sp.; Neoplagualax, cf. N. hazeni; Neoplagiaulax, new species; Ectypodus, cf. E. powelli; Microcosmodon woodi.

Marsupicarnivora: Peradectes elegans.

Lipotyphla: Litocherus, cf. L. notissimus; Litocherus, cf. L. zygeus; Leptacodon, cf. L. packi.

Dermoptera: Elpidophorus elegans.

Primates: Microsyopidae, unidentified genus and species; Ignacius frugivorus; Plesiadapis rex; Nannodectes simpsoni; Carpodaptes hazelae; Elphidotarsius wightoni; Zanycteris palaeocena; Saxonella, new species.

Carnivora: Raphictis, cf. R. gausion; Raphictis sp.

Condylarthra: Ectocion wyomingensis.

Eutheria, order incertae sedis, Palaeoryctidae: Palaeoryctes, cf. P. punctatus; Pararyctes pattersoni; Pararyctes, new species. Pantolestidae: Propalaeosinopa septentrionalis. Pentacodontidae: Bisonalveus sp. Apatemyidae: unidentified genus and species.

BLINDMAN RIVER, LOCALITIES DW-1, MEL'S PLACE, DW-2, DW-3

Paskapoo Formation, middle Tiffanian (Ti_3)

(Fox, 1984a-d; in preparation)

These localities are outcrops of the Paskapoo Formation along successive cutbanks of the Blindman River ("Paskapoo" is the Cree name given the Blindman River [L. S. Russell, 1965]), southeast of the village of Blackfalds, Alberta. Figures 2 and 3 show their distributions on regional and local scales. D. Wighton discovered DW-1, 2 and 3 in 1977; M. Fox discovered Mel's Place in 1981. They are located in S 13-14, T 39, R 27, W 4, at an altitude of about 838 m above sea level.

At the Blindman River localities, the Paskapoo Formation consists mostly of sombre gray-greenish, brown and black shales, mudstones, siltstones, sandstones and limestones, together representing deposition associated with slowly flowing streams, shallow lakes and swamps. The mammalian bones are normally disarticulated, but they show no evidence of depositional abrasion, so were probably not transported far from place of death to final burial. Some show tooth-marks, evidence of (prolonged?) subaerial exposure before burial. All of the mammalian fossils collected from these localities have been from species of small body size, with the largest represented by rare fossils of Cyriacotherium (Pantodonta) and of condylarths such as Colpoclaenus and Ectocion. Two extensively preserved multituberculate skeletons have been found at DW-2, in addition to several incomplete mammalian skulls. Many of the remaining identifiable mammals are represented by incomplete jaws with teeth, but preservation of the anterior parts of the dentition is not uncommon, a rarity for small mammals of this age. Prominent among the non-mammalian vertebrates at these localities are fossils belonging to a necrosaurid lizard.

DW-1, the first of the Blindman sites that Wighton found, appears now to be exhausted: it evidently consisted of a small lens of concentrated, well preserved remains. It was worked extensively

in 1978 and 1979, mostly by the author. DW-2 has yielded a large and important collection of exceptionally preserved mammalian fossils; it was quarried extensively in 1978-84, and 1986-87. Mel's Place has been little sampled: access to it is difficult at all but the lowest river levels. Mammals collected from DW-3 include only the few teeth and tooth fragments that Wighton found on discovery of the site: the fossils occur in a loose sandstone containing clay galls and molluscan shells, and are probably best sampled by underwater screening (yet to be undertaken). At DW-1 and 2, and Mel's Place, the mammals occur in shales that are hand-quarried to best assure recovery without breakage. The Blindman River localities are within sight of one another, and can be correlated directly, by reference to the same lignites and mollusc-rich beds as markers. The occurrence of what appears to be a primitive stage in the upper molar evolution of Plesiadapis rex at DW-2 indicates that the Blindman localities are probably early middle Tiffanian in age. A preliminary list of mammalian species at DW-2 was published in Fox (1984c), which the present list is intended to replace. During May-July, 1988, a large collection of exceptionally well preserved mammalian fossils, including a skull and associated lower jaws of Neoplagiaulax, was made at DW-2, owing to unusually low water levels permitting access to parts of the cutbank not previously available for sampling.

DW-1

Multituberculata: Ptilodus, new species 2 of Krause (1982); Mimetodon silberlingi.

Marsupicarnivora: ?Peradectes sp.

Lipotyphla: Litocherus, cf. L. zygeus; "litolestine", new genus and species; Erinaceidae, new genus and species; Leptacodon packi.

Dermoptera: Elpidophorus elegans.

Primates: Elphidotarsius wightoni; Carpodaptes hazelae; Carpodaptes cygneus (cf. Swan Hills species).

Condylarthra: Colpoclaenus keeferi.

Eutheria, order incertae sedis, Pentacodontidae: Bisonalveus, new species.

Mel's Place

Primates: Carpodaptes hazelae.

DW-2

Multituberculata: Ptilodus, new species 2 of Krause (1982); Prochetodon, new species; Mesodma pygmaea; Ectypodus, species 1; Ectypodus, species 2; Neoplagiaulax, cf. N. hunteri; Neoplagiaulax, cf. N. hazeni; Neoplagiaulax, new species 1-3; Microcosmodon woodi.

Marsupicarnivora: Peradectes elegans.

Lipotyphla: Litocherus, cf. L. notissimus; Litolestes ignotus; Diacocherus minutus; Erinaceidae, new genus and species; ?Erinaceidae, unidentified genus and species 1; ?Erinaceidae, unidentified genus and species 2; ?Erinaceidae, unidentified genus and species 3; Leptacodon packi.

Dermoptera: Elpidophorus elegans.

Primates: Micromomys fremdi*; Microsyopidae, unidentified genus and species 1; Microsyopidae, unidentified genus and species 2; Ignacius frugivorus; Plesiadapis rex?; Plesiadapis sp.; Elphidotarsius wightoni*; Carpodaptes hazelae; Saxonella crepaturae; Zanycteris palaeocena.

Carnivora: Protictis paralus; Raphictis, cf. R. gausion.

Condylarthra: Colpoclaenus keeferi; Metachriacus, new species; Claenodon, cf. C. ferox; Arctocyonidae, new genus and species 1; Arctocyonidae, new genus and species 2. ?Hyopsodontidae, new genus and species.

Pantodonta: Cyriacotherium, cf. C. argyreum.

Eutheria, order incertae sedis, Palaeoryctidae: Pararyctes, new species 1; Pararyctes, new species 2. Leptictidae: ?Prodiacodon, new species. Pantolestidae: Propalaeosinopa albertensis; Propalaeosinopa septentrionalis. Pentacodontidae: Bisonalveus, new species; Aphronorus sp. Mixodectidae: Eudaemonema, new species. ?Apatemyidae: unidentified genus and species.

DW-3

Multituberculata: Neoplagiaulax, cf. N. hazeni.

Primates: Carpodaptes hazelae.

Eutheria, order incertae sedis, Pentacodontidae: Bisonalveus, new species.

BURBANK

Paskapoo Formation, middle Tiffanian (Ti_2)

(Fox, in preparation)

"Burbank" is the name given to an extensive series of outcrops at the confluence of the Blindman and Red Deer rivers, 1.2 km from the Blindman River localities, and in S 13, T 39, R 27, W 4, approximately 838 m above sea level. Most of the outcrop at Burbank consists of poorly bedded

gray siltstones and shales that contain well preserved leaf impressions and insect remains (Taylor and Stockey, 1984); the gray beds are capped by a more resistant, cliff-forming brown sandstone. E. Speirs collected the first mammalian fossil from Burbank in the summer of 1977. The specimen is a well preserved dentary with teeth of Propalaeosinopa albertensis, and was the first Paskapoo mammal to be discovered in the area. Mammals are not common at this locality, in contrast to its abundant plant and insect remains.

Condylarthra: Colpoclaenus keeferi.

?Pantodonta: unidentifed genus and species.

Eutheria, order incertae sedis, Pantolestidae: Propalaeosinopa albertensis; Propalaeosinopa septentrionalis.

JOFFRE BRIDGE ROADCUT

Paskapoo Formation, middle Tiffanian (T_1)

(Fox, in preparation)

Approximately 12 km east of Red Deer and south of the Joffre Bridge across the Red Deer River, relocation of Provincial Highway 11 in 1978 produced a roadcut exposing highly fossiliferous beds in the Paskapoo Formation. This roadcut is located in NW1/4 S 13, T 38, R 26, W 4. In 1978, D. Wighton first found mammals at this locality, at an horizon now named "Joffre Bridge Roadcut, lower level", at about 818 m above sea level. From 1978 to the present, E. Speirs has quarried for fossils at the Joffre Bridge Roadcut, but mostly at an horizon 20 m above the lower level, collecting many valuable plant and insect specimens (Taylor and Stockey, 1984) and discovering rich deposits of teleost fishes (under study by M. V. H. Wilson, UAI.VP). This upper level has yielded several isolated mammalian jaws and, in 1986, the skull and postcranial skeleton of a large pantodont,

probably Titanoides, also found by Speirs: the isolated jaws occur in an indurated black shale containing abundant molluscan shells, whereas the pantodont was excavated from poorly lithified brown mudstones and siltstones directly above the mollusc layer.

Speirs and field parties from the UALVP have worked the lower level intermittently, from 1979 to 1982, and in 1986. Here isolated teeth, jaw fragments with teeth, and the isolated bones of small mammals are found in a black shale only a few centimeters thick; the shale is directly beneath a massive sandstone that appears devoid of vertebrate fossils.

From the primates occurring at the lower level, its age is probably middle Tiffanian. Mammals from the upper level are consistent with this age, but are represented so far only by long-ranging species that themselves are not diagnostic. A peculiarity of the beds at the Joffre Bridge Roadcut is the apparent absence of Bisonalveus, one of the most abundant therians at the Blindman River localities and Hand Hills West, upper level, which are approximately correlative with the Roadcut beds.

Joffre Bridge Roadcut, lower level

Multituberculata: Ptilodus, new species 1 of Krause (1982); Prochetodon, new species; Mesodma pygmaea; Mimetodon silberlingi; Neoplagiaulax, cf. N. hunteri; Neoplagiaulax, cf. N. hazeni; Neoplagiaulax, new species.

Marsupicarnivora: Peradectes elegans.

Lipotyphla: Litocherus, cf. L. notissimus; Litocherus, cf. L. zygeus; Litolestes ignotus; Erinaceidae, new genus and species. Lipotyphla, unidentified genus and species.

Dermoptera: Elpidophorus elegans.

Primates: Microsyopidae, unidentified genus and species; Ignacius frugivorus; Carpodaptes hazelae.

Condylarthra: Arctocyonidae, unidentified genus and species; Ectocion wyomingensis.

Pantodonta: unidentified genus and species.

Eutheria, order incertae sedis, Palaeoryctidae: Pararyctes pattersoni; cf. Stilpnodon sp.; Palaeoryctidae, unidentified genus and species. Pantolestidae: Propalaeosinopa albertensis; Propalaeosinopa septentrionalis.

Joffre Bridge Roadcut, upper level

Lipotyphla: Litocherus, cf. L. zygeus.

Pantodonta: cf. Titanoides sp.

JOFFRE BRIDGE, MAMMAL SITE NO. 1

Paskapoo Formation, middle Tiffanian (Ti_3)

(Fox, in preparation)

Directly across the Red Deer River from the Joffre Bridge Roadcut is another locality, "Joffre Bridge, Mammal Site No. 1", in a high river bank exposing gray shales and siltstones of the Paskapoo Formation; this bank is located in NW1/4 S 13 and SW1/4 S 24, T 38, R 26, W 4, at about 830 m above sea level. The fossils occur at approximately 22 m above river level, in a dark gray to brown or black shale rich in broken molluscan shells. The shell bed lies immediately beneath a thin,

fissile black shale, which in turn is beneath a lignite. Amia bones and scales and Champsosaurus bones are common in the shell bed; mammalian fossils (jaws with teeth, skull parts) are usually well preserved, but are rare. D. W. Krause found the first mammals at this site in July 1974, and he collected additional specimens in 1977. Beginning in 1978, E. Speirs quarried here with good success, as have field parties from UALVP since 1979.

Multituberculata: Ptilodus, new species 1 of Krause (1982); Prochetodon, new species;

Marsupicarnivora: unidentified genus and species.

Lipotyphla: Litocherus, cf. L. notissimus; Litocherus, cf. L. zygeus; Diacocherus minutus.

Dermoptera: Elpidophorus elegans.

Pantodonta: Titanoides sp.

Eutheria, order incertae sedis, Pantolestidae: Propalaeosinopa albertensis.

ERICKSON'S LANDING

Paskapoo Formation, middle Tiffanian (T_1)

(Simpson, 1927; Krause, 1978)

In 1910, a field party from the American Museum of Natural History collected a small sample of mammalian remains from a slump block on the Red Deer River at Erickson's Landing ("about 20 miles below the town of Red Deer" [Simpson, 1927: 1]). These fossils provided the first record of Paleocene mammals in Canada (although this was not recognized until later [Simpson, 1927]), but the exact place at which they were found has been in doubt (see Krause, 1978: 1266).

L. S. Russell (personal communication, May, 1988) has kindly informed me that he visited the American Museum locality in 1924 and photographed it in 1928, when remains of the slumped shell layer were still in place. His photographs show the slump to have been at the river bank containing Joffre Bridge Mammal Site No. 1, but he points out that there is no way to determine from which of two shell beds cropping out there the slump block was derived; consequently, I have listed the Erickson's Landing mammals separately from those at Mammal Site No. 1. Simpson (1927) described the original faunule, which included the holotypes of two new genera and species. The occurrence of Plesiadapis rex in this faunule indicates a middle Tiffanian age (Gingerich, 1976; Krause, 1978).

Primates: Plesiadapis rex.

Dermoptera: Elpidophorus elegans**.

Condylarthra: Ectocion sp.

Eutheria, order incertae sedis, Pantolestidae: Propalaeosinopa albertensis**.

JOFFRE BRIDGE EAST

Paskapoo Formation, middle Tiffanian (Ti$_2$)

(Fox, in preparation)

In the summer of 1987, D. B. Schowalter collected an incomplete shearing blade of an unidentified multituberculate from a mollusc layer in the Paskapoo Formation east of Joffre Bridge, in NE1/4 S 13, T 38, R 25, W 4; the site is approximately 861 m above sea level, exposed on the bank to the north of Highway 11 as it descends to the Joffre Bridge. In altitude, the layer at Joffre Bridge East approaches that at Canyon Ski Quarry (q.v.) about 8 km to the northwest, and on that basis

might be equivalent in age, but I have listed it with the other Joffre Bridge localities until a difference in age can be shown.

Multituberculata: unidentified genus and species.

JOFFRE PIPELINE

Paskapoo Formation, middle Tiffanian (Ti_3)

(Fox, in preparation)

This locality was discovered during excavation in the Paskapoo Formation for a natural gas pipeline crossing the Red Deer River 4.5 km downstream from the Joffre Bridge; it is located southeast of the village of Joffre, in SE1/4 S 9, T 38, R 25, W 4, at about 823 m above sea level. E. Speirs collected the mammals - three teeth/tooth fragments - in August 1986, and they are catalogued in the collections of the Tyrrell Museum of Palaeontology, Drumheller. Owing to the nearness of the Joffre Bridge localities, which are at a similar altitude, the fossils at Joffre Pipeline are probably middle Tiffanian in age.

Condylarthra: Colpoclaenus sp.

CANYON SKI QUARRY

Paskapoo Formation, late Tiffanian (Ti_4)

(Krause, 1978; Fox, in preparation)

The Canyon Ski Quarry locality is located immediately east of Red Deer, in the Paskapoo Formation exposed at the top of the Red Deer River valley, in N1/2 S 29, T 38, R 26, W 4, at about 921 m above sea level; the fossiliferous layer crops out at a cut for a road descending to the Canyon Ski Lodge, a resort on the floor of the valley. D. W. Krause discovered this locality in August, 1976;

Krause (1978) recorded the occurrence there of the primate Carpodaptes cygneus, as yet the only mammal described from the site.

At Canyon Ski Quarry, the mammalian fossils occur in a grayish-brown shale in association with broken molluscan shells; the productive layer is about .5 m thick. The concentration of mammalian fossils in the layer appears to be low, and underwater screening of the shale is the only collecting technique that has been employed and that seems practical for the future. This locality is important because it is one of the few from Canada that can be shown to be in superposition to other occurrences of Paleocene mammals - in this instance, to those at Joffre Bridge (q.v.) approximately 7 km downstream. From the occurrence of Carpodaptes cygneus, Krause (1978: 1269) believed that the Canyon Ski Quarry local fauna is probably late Tiffanian in age.

Multituberculata: Neoplagiaulax sp.

Lipotyphla: Litolestes ignotus; Diacocherus meizon; Leptacodon packi.

Primates: Ignacius frugivorus; ?Nannodectes sp.; Carpodaptes cygneus.

ONE-JAW GAP

Paskapoo Formation, late Tiffanian (Ti_4?)

(Fox, in preparation)

This locality, discovered by K. Soehn and the author in July 1987, is at a large roadcut approximately 3 km northeast of Canyon Ski Quarry, in NW 1/4 S 34, T 38, R 26, W 4, at about 975 m above sea level. An incomplete mammalian dentary with at least one molar and an isolated upper molar, both unidentifed at this writing, were collected from this cut, which, from its altitude, is probably at least as high stratigraphically as is the Canyon Ski Quarry directly across the Red Deer

River. In July 1988, Gao Keqin collected an additional specimen for UALVP, a p4 of a small neoplagiaulacid multituberculate; I, while finding no mammals at this site in 1988, discovered exceptionally well preserved leaf impressions of substantially different facies than those at the Joffre Bridge Roadcut; Dr. R. A. Stockey (Department of Botany, UA) and E. Speirs have begun to make major collections from this site, whixh already enable the reconstruction of nearly complete plants for at least two angiosperm species.

Multituberculata, Neoplagiaulacidae: unidentified genus and species.

Mammalia: unidentified genus and species.

GAO MINE

Paskapoo Formation, late Tiffanian (Ti_4)

(Fox, in preparation)

This locality is at a roadcut along Provincial Secondary Highway 595, 11 km east of Red Deer, in SW 1/4 S 3, T 38, R 26, W 4 and NW 1/4 S 34, T 37, R 26, W 4, at approximately 1013 m above sea level; the first mammals were discovered by Gao Keqin, in July, 1988, and quarrying by Gao and Fox continued until mid-August. At this writing, only a very incomplete faunal list can be provided; Gao Mine is included here because of the exceptional preservation of specimens collected so far, routinely matching that of the very best specimens from DW-2. Plesiadapis is relatively abundant at Gao Mine, in contrast to all other localities worked by UALVP. If results so far are a reliable guide, the Gao Mine will prove to be among the most important Paleocene mammal localities in Canada. Owing to the very preliminary work done so far we will not be collecting at this site, although we will stop there.

Multituberculata: Ptilodus sp.; Baiotomeus sp.; Ectypodus sp. (articulated skull and lower jaws); Microcosmodontinae, unidentified genus and species (including skull).

Lipotyphla: Erinaceidae, unidentified genus and species; ?Nyctitheriidae, unidentified genus and species (articulated skull, lower jaws and anterior skeleton).

Primates: Plesiadapis, cf. P. churchilli; Carpodaptes, cf. C. hazelae.

Condylarthra: Ectocion sp.

KUA-1

Scollard Formation, Lancian

(Clemens and Russell, 1965; Lillegraven, 1969; Fox, 1974, in press, a)

KUA-1 is one of the most important Late Cretaceous mammal localities known. It occurs in the lower part of the Scollard Formation, approximately 13 m below the Nevis coal zone, marking the Cretaceous-Tertiary boundary (Lerbekmo, et al., 1979). Mammalian specimens from KUA-1 furnished most of the fossils for J. A. Lillegraven's (1969) doctoral dissertation on the Scollard mammals; this collection is catalogued in the UALVP.

Perhaps the greatest significance of KUA-1 lies in its documentation of an increase in the diversity of placental mammals relative to marsupials and multituberculates well before the extinction event(s) that marked the end of the Mesozoic: recent commentators (e.g., Smit and van der Kaars, 1984) have sometimes missed that point. Further, KUA-1 contains rare fossils that appear to be closely related to the enigmatic mammalian family Deltatheridiidae, otherwise known only from the Upper Cretaceous of the Gobi Desert, Mongolian People's Republic (Fox, 1974). The Scollard deltatheridiids provide one of the more direct lines of evidence for correlation of the Mongolian

mammal-bearing Upper Cretaceous with that in North America (Fox, 1978; Lillegraven and McKenna, 1986). The list of species from KUA-1 is from Lillegraven (1969), with emendations as appropriate from subsequent work; no field collections after Lillegraven's have been made from the locality.

Multituberculata: Mesodma hensleighi; Mesodma formosa; Mesodma thompsoni; Cimexomys sp. (Fox, in press, a); Paracimexomys priscus (see Archibald, 1982); Cimolodon nitidus; Ptilodontidae, unidentified genus and species; Cimolomys gracilis; Cimolomys trochuus.

Marsupicarnivora: Alphadon marshi; Alphadon wilsoni; Alphadon rhaister; Pediomys elegans; "Pediomys" krejcii; "Pediomys" hatcheri; Didelphodon vorax.

Eutheria, order incertae sedis, Palaeoryctidae: Cimolestes cerberoides; Cimolestes propalaeoryctes; Cimolestes magnus; Batodon tenuis. Leptictidae: Gypsonictops hypoconus; Gypsonictops illuminatus. Family incertae sedis, new genus and species (Fox, in press, a).

Tribotheria, Deltatheridiidae, unidentified genus and species (Fox, 1974).

Epilogue

By 1958, there were nine localities at which Paleocene mammals had been discovered in western Canada, all in Alberta (L. S. Russell, 1958); no more than a total of 50 specimens were known from these sites. By the beginning of summer 1988, 41 Paleocene mammal sites had been discovered in western Canada, most in Alberta, but some in Saskatchewan, as well (see Fox, in press, b), and most since 1966, by field parties from UAI VP. Little from these collections has been described. In 1988, additional progress was made: the discovery of the Gao Mine was especially significant, but further, G. Stonley and G. P. Youzwyshyn found Paleocene mammals at several new

sites west of Highway 2 north of Cochrane, in the Porcupine Hills and Paskapoo formations. At least one of these sites, near Bentley, Alberta, seems especially promising. In any case, the record of Paleocene mammals from western Canada, which was for so long merely an appendage to that from the United States (as in Sloan [1987], for example), is now a major resource in its own right, comparable to the record of Late Cretaceous mammals from Alberta and Saskatchewan in that regard (see Fox, 1988, in press, a, b). Dinosaurs from Alberta? Sure, but how much more in heaven and earth than is dreamt of in that philosophy!

G. Denomme, Gao Keqin, Dr. P. A. Johnston, Dr. D. W. Krause, E. Speirs, G. Stonley, the late D. Wighton, and G. P. Youzwyshyn have been important contributors to building the collections on which my studies of Late Cretaceous and Paleocene mammals from western Canada are based.

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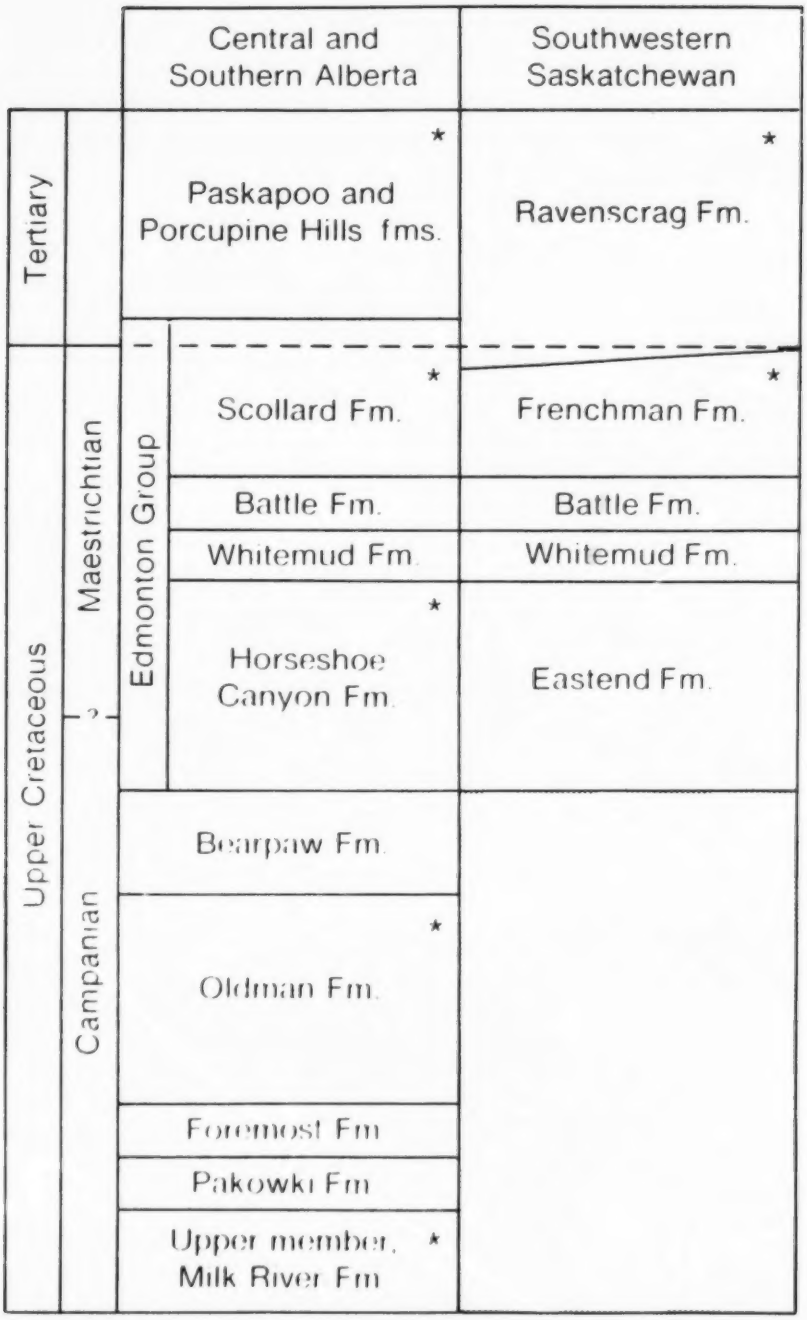

Fig. 1. Correlation chart showing (asterisks) Upper Cretaceous and Paleocene mammal-yielding formations in Alberta and Saskatchewan.

Fig. 2. Map showing distribution of Paleocene mammal localities in Alberta and Saskatchewan known prior to summer 1988. Localities in this guide include: 6) Calgary 2E and Dunbow Road; 7) Cochrane 1; 10) Cochrane 3; 11) Hand Hills East; 12) DW 1; 13) DW 2; 14) Mel's Place; 15) DW 3; 16) Burnham; 17) Joffre Bridge localities; 18) Erickson's Landing; 19) Hand Hills West; 20) Carbon Sk; Quarry and One Tree Gap; Various Localities, Gao Mine and E.U.V. Tarr not shown.

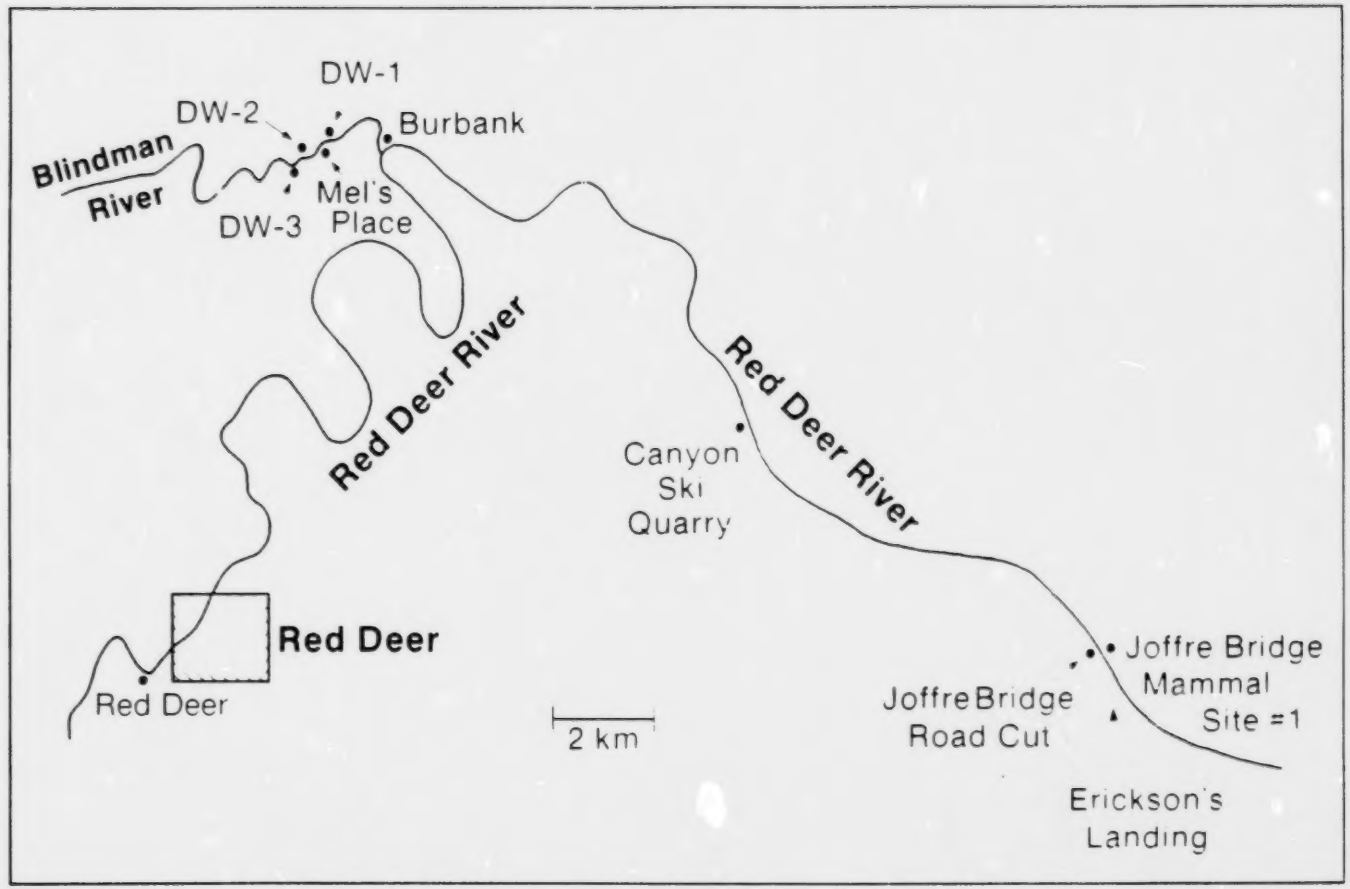

Fig. 3. Map showing distribution of mammal localities in the Passage Formation in the vicinity of Red Deer, Alberta. Gas Mine (not shown) is 12 km east of Red Deer.